National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: May 22, 1997

In reply refer to: A-97-29 and -30

Mr. Barry L. Valentine
Acting Administrator
Federal Aviation Administration
Washington, DC 20591

Timely, complete, and accurate flight data recorder (FDR) data are critical to accident investigations so that government and aviation industry personnel can quickly identify safety problems and take proper corrective actions. However, in its recent investigations of aviation accidents and incidents, the National Transportation Safety Board has encountered numerous problems related to the documentation of FDR systems. The lack of adequate documentation of these FDR systems has prevented an accurate and complete readout of the FDR data and, consequently, a clear understanding of the circumstances surrounding the accidents. The Board's investigations of these accidents have also revealed that some FDR systems were not recording parameters required by the regulations. These problems have been especially prevalent for airplanes that were retrofitted with FDRs that are required to record 11 parameters per Title 14 Code of Federal Regulations Section 121.343(c) [1] (14 CFR 121.343(c)). The preponderance of retrofitted airplanes with 11-parameter FDRs suggests either inadequate installations or maintenance of the FDR systems. During the past 2 years, the Safety Board has encountered problems extracting data from retrofitted FDRs recovered from the following accident/incident-involved airplanes:

Millon Air airplanes:

Accident # MIA97RA011, B707, Manta, Ecuador, occurred on 10/22/96.
Insufficient FDR documentation. Does not meet requirements in 14 CFR 121.343(c).

Accident # MIA95RA121, DC-8, Guatemala City, Guatemala, occurred on 04/28/95.
Insufficient FDR documentation. Does not meet requirements in 14 CFR 121.343(b). Also would not have met the requirements in 14 CFR 121.343(c) that would have become applicable to this airplane 28 days after the accident.

[1] Airplanes manufactured before May 26, 1989, that were type certificated before September 30, 1969, must meet the following requirements: 14 CFR 121.343(b) requires digital recording of the following six FDR parameters: time, altitude, airspeed, vertical acceleration, heading, and time of each radio transmission. 14 CFR 121.343(c), which became effective on May 26, 1995 (the original compliance date for 14 CFR 121.343(c) was extended 1 year beyond May 26, 1994), requires the following additional parameters: pitch attitude, roll attitude, longitudinal acceleration, control column or pitch control surface position, and thrust of each engine.

ValuJet airplanes:

Accident # DCA96MA054, DC-9, Miami, FL (Everglades), occurred on 05/11/96.
Insufficient FDR documentation.[2] Does not meet requirements in 14 CFR 121.343(c).[3]

Accident # ATL96IA056, DC-9, Savannah, GA, occurred on 02/28/96.
Insufficient FDR documentation.

Accident # ATL96FA043, DC-9, Nashville, TN, occurred on 02/01/96.
Insufficient FDR documentation.

Accident # MIA96FA059, DC-9, Nashville, TN, occurred on 01/07/96.
Insufficient FDR documentation.

Air Transport International airplane:

Accident # DCA95MA020, DC-8, Kansas City, MO, occurred on 02/16/95.
Insufficient FDR documentation. Also would not have met requirements in 14 CFR 121.343(c) that would have become applicable to this airplane 3 months after the accident.

Express One airplane:

Accident # DCA97WA007, B727, Orebro, Sweden, occurred on 11/12/96.
Insufficient FDR documentation.

The Millon Air accidents best illustrate specific problems encountered from the retrofitted FDRs. On April 28, 1995, a Millon Air DC-8F conducting a supplemental cargo flight from Miami, Florida, ran off the end of the runway after landing at La Aurora International Airport in Guatemala City, Guatemala. The investigation was severely hampered by the following deficiencies: (a) there was insufficient documentation of the FDR system to develop conversion equations; (b) the FDR recorded only 8 of the required 25 hours of data; (c) normal and longitudinal acceleration parameters were inactive; (d) altitude and engine pressure ratio (EPR) for all four engines were recording the same erroneous signal input; and (e) the airspeed values were erroneous. Normal (vertical) acceleration, altitude, and airspeed were required by 14 CFR 121.343(b) to be recorded at the time of the accident; consequently, the FDR on the accident airplane did not meet FAA requirements.[4] These deficiencies raised serious questions regarding the validity of the remaining parameters (pitch, roll, heading, and elevator position) and failed to yield critical data required by the Safety Board for reconstruction of the airplane motion and crew performance.

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[2] The values recorded for the parameter control column position (a mandatory parameter per 14 CFR 121.343(c)) were not consistent with the FDR system documentation provided by the operator. To resolve this problem, the FDR group conducted tests on two different ValuJet DC-9 aircraft before developing a conversion algorithm that yielded accurate control column position data for the accident aircraft.

[3] Longitudinal acceleration not recorded.

[4] Because longitudinal acceleration and engine pressure ratio were not recorded, the FDR system also would not have met the requirements of 14 CFR 121.343(c) that would have become applicable to this airplane 28 days after the accident.

On October 22, 1996, a Millon Air Boeing 707-323C conducting a supplemental cargo flight crashed after takeoff from the Eloy Alfaro Airport in Manta, Ecuador. The government of Ecuador is investigating the accident in which 33 people were killed, and the Safety Board performed the FDR readout at the request of the Ecuadorian investigator-in-charge. The FDR in the accident airplane had two inactive FDR parameters: control column position and EPR for engine no. 2. These parameters are required by 14 CFR 121.343(c); consequently the FDR did not meet FAA requirements. Further, documentation needed to convert raw FDR data to engineering units was insufficient. As a result, Safety Board staff derived approximate calibrations for EPR for engine nos. 3 and 4 using the EPR for engine no. 1. The derived calibrations were based on the assumption that thrust was increased symmetrically on all four engines. Because the flight crew believed an engine failure occurred and pulled back the no. 3 engine, the FDR data on engine performance is critical to the investigation. Approximate calibrations based on the assumption that thrust was increased symmetrically may not be reflective of actual operating conditions.

The deficiencies in the FDRs of these Millon Air airplanes raise questions about the carrier's procedures regarding the installation, maintenance, and documentation of the FDR systems in its fleet. Further, because the Safety Board has encountered the same or similar FDR problems in its investigations of accidents/incidents involving three other carriers and six airplanes in the past 2 years, the Safety Board is concerned that problems regarding the installation, maintenance, and documentation of 11-parameter FDRs may exist with other carriers. Consequently, the Safety Board believes that the FAA must take prompt action to ensure compliance of the U.S. carriers subject to 14 CFR 121.343(c). Actions should include (a) performing a readout of each retrofitted airplane's 11-parameter FDR to determine that all required FDR parameters are being recorded and to verify that each parameter is working properly; and (b) reviewing the FDR system documentation to determine compliance with the range, accuracy, resolution, and recording interval specified in 14 CFR Part 121, Appendix B.

On March 1, 1991, the Safety Board addressed the airworthiness of FDRs in two safety recommendations issued to the FAA. The Board's letter detailed the problems experienced in extracting FDR data during several accident/incident investigations. As a result of these problems, the Board asked the FAA to develop permanent policy and guidance material for the continued airworthiness of FDR systems that requires operators to maintain, as part of the aircraft records, specific information related to the make and model of the FDR, the make and model of the flight data acquisition unit (if installed), and recorder parameters (Safety Recommendation A-91-23). The Board also asked the FAA to require operators to maintain the specific information for each unique FDR configuration in their inventory using a single, universally adopted format (Safety Recommendation A-91-24).

In its response of December 18, 1991, to these recommendations, the FAA stated it was "...planning to develop an advisory circular (AC) to address the installation and maintenance of digital flight data recorders (DFDR) and flight data acquisition units. The AC will reference the appropriate regulatory requirements and will contain the universal documentation format for each DFDR aircraft configuration and installation." The Safety Board replied on January 28, 1992, that it was encouraged by the FAA's plan to issue the AC. However, considerable time passed

without progress by the FAA, and on April 22, 1994, the Safety Board reclassified Safety Recommendations A-91-23 and -24 "Open--Unacceptable Action."

The need for long-term measures to ensure adequate system documentation is most recently illustrated by the Express One incident that occurred on November 12, 1996. In this incident, a U.S. registered Boeing 727 (N263US) overran the runway when landing at Orebro airport (ESOE), Sweden. Although the Swedish government is investigating the incident, the Safety Board is performing the FDR readout at the request of the Swedish investigator-in-charge. When Safety Board staff contacted the operator to get the documentation necessary to read out the FDR (including conversion equations, sampling rates, and word slot locations), staff were informed that Express One could not provide any of the needed documentation and that the FDR had been upgraded from 5 to 11 parameters on December 18, 1994, by J&L Avionics Engineering Service of Miami, Florida. Despite multiple telephone calls to J&L Avionics, Safety Board staff still have not received any documentation on the parameter conversion equations. Without the documentation specific to this FDR system, the staff have had to use generic information from the Board's laboratory archives for similar FDR configurations to read out the recorder and, therefore, cannot be certain that the data adequately reflect actual operating conditions. The Safety Board believes that more timely action in response to the Board's 1991 recommendations would have addressed the recent difficulties associated with reading retrofitted 11-parameter FDRs.

On July 16, 1996, the FAA issued a notice of proposed rulemaking (NPRM) that addresses revisions to digital flight data recorder rules (Federal Register, Vol. 61, No. 137). The notice was prepared in response to a series of safety recommendations that were issued by the Safety Board in February 1995 and added to the Board's list of "Most Wanted" transportation safety improvements in May 1995. The proposed revisions will increase the number of parameters recorded by FDRs and will require a retrofit of FDR systems to be completed within 4 years of the date of the final rule.

As stated in its comments on the NPRM, the Safety Board supports timely issuance of the final rule. The Board also recognizes that the retrofit required by the proposed rules will be more complicated than that required by Section 121.343(c). Given the problems encountered by the Safety Board during the past 2 years with retrofitted 11-parameter FDRs, the Safety Board is concerned that similar problems could be repeated, on a much larger scale, following the proposed retrofit, unless the FAA takes action to ensure that these systems are properly installed and maintained and that documentation of the systems is retained.

To that end, on January 16, 1997, the FAA approved notice N8110.65, which provides guidance to FAA inspectors when they check for compliance with FDR requirements and addresses current problems in FDR documentation. However, the notice does not address specific FDR certification requirements or elements of an FDR maintenance program. Further, the notice will be in effect only until January 16, 1998.

The issues of FDR installation, documentation, and maintenance need to be addressed beyond the expiration date of the notice. Therefore, the Board believes that the FAA should

expedite completion of the planned AC that defines FDR certification requirements and FDR maintenance requirements, and incorporate the FDR documentation standards now contained in notice N8110.65. The AC should be released no later than January 16, 1998, the date that notice N8110.65 expires. Incorporating the FDR documentation standards contained in the notice would also satisfy the intent of Safety Recommendations A-91-23 and -24.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Take action within 180 days to ensure compliance of the U.S. carriers subject to 14 CFR 121.343(c). Actions should include (a) performing a readout of each retrofitted airplane's 11-parameter flight data recorder (FDR) to determine that all required FDR parameters are being recorded and to verify that each parameter is working properly; and (b) reviewing the FDR system documentation to determine compliance with the range, accuracy, resolution, and recording interval specified in 14 CFR Part 121, Appendix B. (A-97-29)
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> Complete the planned flight data recorder (FDR) advisory circular (AC) to define FDR certification requirements and FDR maintenance requirements, and incorporate the FDR documentation standards contained in notice N8110.65. The AC should be released no later than January 16, 1998. (A-97-30)

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By: Jim Hall
Chairman